porous clay plates (77 mm.—3 in.—in diameter) mounted across the large end of a glazed porcelain funnel. The apparatus is made as a single piece, the funnel wall and the disk being continuous, and the lateral surface is afterwards heavily glazed externally. The funnel part is nearly hemispherical, with the cylindrical neck projecting outward from the spherical surface, opposite the center of the porous disk which closes the hemisphere at the top. A vertical section of such a piece is shown in Fig. 1. In operation, the opening

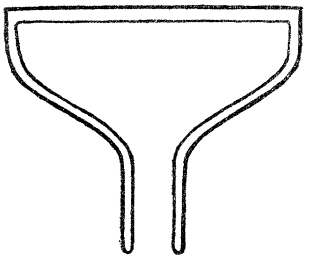

Fig. 1.

is closed by a rubber stopper bearing a tube reaching to the water reservoir below, just as in the case of the ordinary porous cup atmometer. Of course it is not at all essential that the plate be horizontal; it may be exposed in any direction, even downward. All that is necessary is that the water level in the reservoir be at a lower level. It may be mounted on a bottle or a burette, or any convenient form of reservoir, and the non-absorbing mounting may be employed to prevent the absorption of rain. In general, these Bellani plates are to be operated just as are the ordinary porous cups. Where a plane evaporating surface is required, they possess all the advantages of the free water surface and none of its disadvantages. They also possess all the general advantages of the porous cup instrument.

Burton E. Livingston

THE EFFECT OF TEMPERATURE ON THE LIFE CYCLE OF MUSCA DOMESTICA AND CULEX PIPIENS

Owing to a scarcity of data necessary to illustrate the relation of the temperature to the rate of breeding of flies and mosquitoes, a set of experiments was undertaken at the suggestion of Professor C.-E. A. Winslow, to determine (approximately) this relation.

These experiments were made possible through the courtesy of the department of natural history of the College of the City of New York in loaning us three incubators for the purpose.

The experiments began late in July, 1914, and ran through to the middle of September.

An effort was made to eliminate all factors but that of temperature.

Individual variations among different batches of eggs were eliminated by dividing the same batch into three portions to be incubated at the three temperatures.

Larvæ reared from the batches of eggs compared were fed on the same food.

The light, throughout, was either diffused or absent, and the same condition obtained in the batches compared with each other.

By exposing several tumblers of water in each incubator, the atmosphere was kept in a high state of saturation.

All vials containing the breeding fly larvæ were of the same cross section and the height of manure was about the same in each, *i. e.*, from 1½ to 2 inches; the mosquito-larvæ vials and infusions were also uniform.

From the above it will be seen, that although the results may not indicate a breeding rate generally true for each temperature, they nevertheless offer a fair comparative study of the rate at the three temperatures.

Experiments with Flies

Experiments with the life cycle of flies will be treated first.

Egg batches were obtained in the following way: Flies were caught by net and females with gorged abdomens selected. These were first placed together in large fruit jars containing rotten fruit (plums), and the jar was

TABLE I

Average Duration of Each Stage—Flies

Temp.	Egg Stage	Larva	Pupa	Total
20°	1.2 da.	12.3 da.	8.8 da.	22.3 da.
30°	1 da.	5.1 da.	4.2 da.	10.3 da.
35°	1 da.	4.3 da.	4.0 da.	9.3 da.

TABLE OF RECORDED RESULTS OF WORK WITH FLIES

Sample.	Temp.	Stages.			Total.
		Egg.	Lar.	Pup.	
A					
	20°	1 da.	14 da.	9 da.	24
	30°	1 da.	7 da.	5 da.	13
	35°	1 da.	Molds		
B					
	20°	1 da.?	13 da.	10 da.	24
	30°	1 da.	7 da.	5 da.	13
	35°	1 da.	6 da.	4 da.	11
C					
	20°	1 and 2 da.	17 da.	5 da.	23
	30°	1 da.	6 da.	4 da.	11
	35°	1 da.	6 da.	4 da.	11
D					
	20°	1 da.	?	?	24*
	30°	1 da.	7 da.	4 da.	12
	35°	Molds			
E					
	20°	1 da.	13 da.	9 da.	23
	30°	Molds			
	35°	1 da.	4 da.	5 da.	10
F					
	20°	1 and 2 da.	13 da.	11 da.	25
	30°	Molds			
	35°	Molds			
G					
	20°	1 da.	?	?	24*
	30°	1 da.	Molds		
	35°	1 da.	Molds		
H					
	20°	1 da.	?	?	23*
	30°	1 da.	5 da.	3 da.	9
	35°	Molds			
I					
	20°				
	30°	Parasitized			
	35°				
J					
	20°	2 da.	8 da.	9 da.	19
	30°	1 da.	4 da.	5 da.	10
	35°	1 da.	4 da.	3 da.	8
K					
	20°	1 da.	8 da.	9 da.	18
	30°	1 da.	3 da.	4 da.	8
	35°	1 da.	3 da.	4 da.	8
L					
	20°	1 da.	15 da.	——	
	30°	1 da.	3 da.	4 da.	8
	35°	1 da.	3 da.	4 da.	8
M					
	20°	1 da.	7 da.	——	
	30°	1 da.	4 da.	4 da.	9
	35°	1 da.			
N					
	20°	1 da.	11 da.	——	
	30°	1 da.	8 da.	——	
	35°				
O					
	20°	1 da.			
	30°	1 da.	5 da.	——	
	35°				

observed from time to time for deposits. This method proved too cumbersome, and another method was later employed, that of isolating two or three gorged females in a 2-oz. vial over a portion of egg-free manure. Manure from the same dropping was used for all vials in each series.

As egg batches were deposited their removal followed as soon as they were observed.

Each batch was divided into three parts, and the eggs placed in vials on about an inch and a half of egg-free manure and incubated at 20°, 30° and 35° C., respectively.

The manure was examined twice daily, morning and afternoon, by carefully stirring up the manure, and any changes were recorded. Records were made under the following heads: Date of incubation; date of appearance of larvæ; date of appearance of pupæ; date of appearance of adult.

The first series of experiments was greatly hampered by fluctuation in temperatures of the incubators and by the appearance of molds in the fly cultures which in almost all cases prevented the completion of the life cycle. These first experiments are omitted and only those broods that came through without mishap or nearly so are recorded.

The accompanying table gives the average periods for each stage at the three temperatures. (Complete data are appended.)

EXPERIMENTS WITH MOSQUITOES

Batches of eggs were collected every morning from a rain barrel and each batch was divided into three portions, and each portion placed in a 2-oz. vial on the surface of a manure infusion. The manure infusion was selected from a series of tested media since it proved a most satisfactory medium for the larvæ and pupæ. About 1½ grams of manure were added to 40 c.c. of tap water. The vials were incubated at 20° C., room temperature, and 30°, respectively; 35° proved fatal to these insects in most cases. The vials at room temperature were kept out of air currents by placing them in a box. This precaution, however, did not prevent an evening drop in temperature of 5 to 8 degrees, but on the whole the room tempera-

ture was between the two incubator temperatures.

The following table gives the average length of period of each stage:

TABLE II

Average Duration of Each Stage—Mosquitoes

Temp.	Egg Stage	Larva Stage	Pupa Stage	Total
20°	2	14	3.6	19.6
R	1	7.7	3.0	11.7
30°	1	4.8	2.0	7.8

TABLE OF RESULTS OF WORK WITH MOSQUITOES

Sample	Temp.	Stage			Total
		Egg s) (in Day	Larv. (in Days)	Pup. (in Days)	
1					
	20°	2	16	3	21
	R	1	6–8	3	10–12
	30°	1	6		
2					
	20°	2	16	3	21
	R	1	8	3	12
	30°	1	5	2	8
3					
	20°	2			
	R	1		3	12
	30°	1		2	7
4					
	20°	2			
	R	1		4	12
	30°	1		2	7
5					
	20°	2	16	3	21
	R	2	9	2	13
	30°				
6					
	20°	2	13	5	20
	R	1	7	3	11
	30°	1	5	2	8
7					
	20°	2		4	15
	R	1			
	30°	1		2	9

DISCUSSION

A study of Tables I. and II. brings to mind the interesting results of Snyder on the rate of heart beat of the tortoise heart. He found that between temperatures 5° and 30° C., the number of heart beats is doubled to trebled for every rise of 10° C. temperature.

SNYDER'S RESULTS ON THE RELATION OF TEMPERATURE TO THE RATE OF HEART BEAT

Time. Minutes	$T=10°$		$T=20°$		$T=30°$	
	Heart 1	Heart 2	Heart 3	Heart 4	Heart 5	Heart 6
5	9.5	9.5	21.5	21	48	48
10	7	9	21	24	48	44
15	6.7	8.7	19	18	48	40
20	7	8.2	19	16.5	41	
30	7	7	16	14		
40	6.5	7.9	15.5	15.5		
50	6.5	7.9	13.5	16		
60	6.2	7.4	13	15		
80	6.2	6.8	11	14.5		
100	6.5	7.1	10	10		
120	6.4	6.6	8	10		
140	6.5	6	8	9		
160	6.5	5.9	7.6	9		

These results agree with the work of Clausen (reference 2, below) on the amount of CO_2 produced by 100 gr. seeds of lupines in one hour at different temperatures.

CLAUSEN'S RESULTS ON THE RELATION OF TEMPERATURE TO THE AMOUNT OF CO_2 PRODUCED

Temperature	CO_2 Produced
0°	7.27
5°	13.86
10°	18.11
15°	34.37
20°	43.55
25°	58.76
30°	85.00
35°	100.00
40°	115.90
45°	104.45
50°	46.20
55°	17.70

Both the above tables as well as my own show a general agreement with the chemical-physical law of van't Hoff and Arrhenius (reference 2, below) which states that the velocity of chemical reactions is raised to between two and three times its original amount, whenever the temperature advances 10° C.

The more recent work of E. D. Sanderson and L. M. Peairs indicates this same relation of temperature to insect life.

BIBLIOGRAPHY

1. Snyder, C. D., "On Influence of Temperature upon Cardiac Contraction and Its Relation to In-

fluence of Temperature upon Chemical Relation Velocity," University of California Publications, Physiology, Vol. 2, 1905, pp. 125–46.

2. Loeb, "Dynamics of Living Matter," 1906, p. 108.

3. Hertwig, "Archives f. Mikroscop. Anatomie und Entwicklungsgeschichte," 1898, Vol. 51, p. 319.

4. Sanderson, E. D. and L. M. Peairs, "Relation of Temperature to Insect Life," New Hampshire College Agr. Exp. Sta., Bulletin No. 7, December, 1913.

S. D. KRAMER
AMERICAN MUSEUM OF NATURAL HISTORY

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 540th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, April 17, 1915, called to order by Vice-president Rose at 8 P.M., with 50 persons present.

Under the heading Brief Notes, Dr. L. O. Howard called attention to the development of mosquito larvæ and adults in pools of water formed by melting snow in the mountains of New York state, the eggs having been laid on the ground the previous summer in places where pools would be formed.

The first paper of the regular program was by J. D. Hood, "Some Features in the Morphology of the Insect Order Thysanoptera." Mr. Hood gave a general account of the Thysanoptera, called attention to the large amount of systematic work that had been done in it during recent years, and said that it was estimated that about 25,000 forms would be found to exist in the order. He called particular attention to the structure and mechanics of the foot, and to the asymmetrical mouth parts, illustrating the peculiarities of each by diagrams. Mr. Hood's paper was discussed by Dr. Howard.

The second paper of the regular program was by Mr. E. A. Goldman, "Biological Explorations in Eastern Panama." Mr. Goldman gave an account of his work in connection with the Smithsonian Biological Survey of the Panama Canal Zone, in 1912, in extreme eastern Panama, with a view to determining the faunal relations of that section to the Canal Zone and to western Panama. Very little zoological collecting had previously been done in the region which was scarcely better known than in the sixteenth century, at the time of the Conquest.

The region proved to be mainly southern American in faunal characters, with a slight admixture of north and middle American elements. Many South American species apparently reach their northern limits here. The collections of birds and mammals have been identified, and about forty of the mammals and thirty of the birds have been described as new. Among the birds are three new genera, two of them of humming birds. No new genera of mammals were taken, but several had not previously been reported from Panama. A new species of *Capybara* was among the more notable mammals. Spiny rats of the genus *Proechimys* were found common. The tail, normally long in this animal, is lost through some pathological condition in many individuals, and owing to this circumstance the natives believe in the existence of two species.

Mr. Goldman's paper was illustrated by lantern slide views of the country explored, and of objects pertaining to its natural history. It was discussed by Messrs. Wetmore and Lyon.

The third and last paper of the program was by Vernon Bailey, "Notes on Variation Distribution and Habits of the Pocket-Gophers of the Genus *Thomomys*." Mr. Bailey said these rodents constituting a genus of the peculiar American family Geomyidæ are distributed over the western United States extending from Alberta and British Columbia to southern Mexico. They range from the Arctic Alpine to the Tropical zonal areas and are generally abundant in the regions they inhabit. They are burrowers, live almost entirely underground and are probably more restricted in their individual habitats than any other of our native mammals. This to some extent accounts for their great range of variation and the large number of recognizable forms, nearly ninety. Almost every change in climate, soil and environment is reflected by some change in the color, size, proportions, or cranial characters. There is wonderful adaptation in their color to that of the soil inhabited by them, varying from creamy white on the light sands of the lower Colorado River flats to dark browns on the volcanic plateaus of Mexico and Arizona, and almost black along the humid Pacific coast region of northwestern California. There is also a pure black form on the coast of Oregon which may be an extreme case of dichromatism, as there are several species with a well-marked black phase.

Their habit of burrowing enables the gophers to escape many enemies and to adapt themselves to rigorous climatic conditions. In the past this